Exhibit B

Hectorite

From Wikipedia, the free encyclopedia

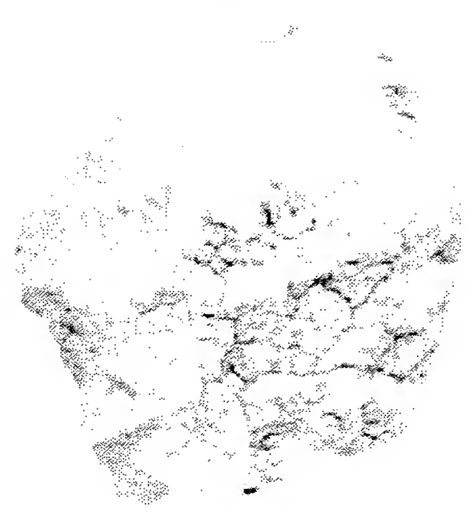
Hectorite is a soft, greasy clay mineral that forms near Hector, California (in San Bernardino County). The mineral is rare in that it is found primarily in one mine. **The chemical composition of hectorite includes: sodium, lithium, magnesium, silicon, hydrogen and oxygen.** Hectorite is mostly used in the manufacturing of cosmetics, but has uses in chemical and other industrial applications.

Hectorite occurs with bentonite as an alteration product of clinoptilolite from volcanic ash and tuff with a high glass content.[1]

References

1. ^ ***a b***
   http://rruff.geo.arizona.edu/doclib/hom/hectorite.pdf Handbook of Mineralogy
2. ^ "Hectorite Mineral Data" Mineralogy Database. <http://webmineral.com/data/Hectorite.shtml
3. ^ Ralph, Jololyn and Ida (2007): "Hectorite" Mineral information and data. Mineralogy Database. http://www.mindat.org/min-1841.html

Hectorite



Hectorite from California

General	
Category	Mineral
Chemical formula	$Na_{0.4}Mg_{2.7}Li_{0.3}Si_4O_{10}(OH)_2$
Identification	
Color	White
Crystal habit	Thin laths and aggregates
Crystal system	Monoclinic
Cleavage	[001] Perfect
Fracture	Uneven
Mohs Scale hardness	1 - 2
Luster	Earthy (dull)
Refractive index	$n\alpha = 1.490$ $n\beta = 1.500$ $n\gamma = 1.520$
Optical Properties	Biaxial - 2V small
Birefringence	$\delta = 0.030$ max.
Pleochroism	Colorless
Streak	White
Specific gravity	2-3 (Avg 2.5)

Hectorite Mineral Data + Pronunciation

General Hectorite Information

Chemical Formula: Na0,3(Mg,Li)3Si4O10(OH)2

Composition: Molecular Weight = 383.25 gm

Sodium	2.40 %	Na	3.23 %	Na_2O
Lithium	0.54 %	Li	1.17 %	Li_2O
Magnesium	17.12 %	Mg	28.39 %	MgO
Silicon	29.31 %	Si	62.71 %	SiO_2
Hydrogen	0.53 %	H	4.70 %	H_2O
Oxygen	50.10 %	O		
	100.00 %		100.21 %	= TOTAL OXIDE

Empirical Formula: $Na_{0.4}Mg_{2.7}Li_{0.3}Si_4O_{10}(OH)_2$

Environment: Clay mineral from altered volcanic tuff ash with a high silica content related to hot spring activity. Smectite group mineral.

IMA Status: Valid Species (Pre-IMA) 1936

Locality: Company No. 1 mine, 3 miles south of Hector, San Bernardino Co., California. Link to MinDat.org Location Data.

Name Origin: Named after it's locality.

Hectorite Image

Images:

Hectorite

Comments: Pure white paper-like matted masses of hectorite.
Location: near Hector, San Bernardino County, California, USA. **Scale:** See Photo.

Hectorite Crystallography

Axial Ratios: a:b:c =0.5718:1:1.7429

Cell Dimensions: a = 5.25, b = 9.18, c = 16, Z = 3; beta = 99° V = 761.63
Den(Calc)= 2.51

Crystal System: **Monoclinic - Prismatic** H-M Symbol (2/m) Space Group: C 2/m

X Ray Diffraction: By Intensity(I/I_o): 1.53(1), 4.58(1), 15.8(0.8),

Physical Properties of Hectorite

Cleavage: [001] Perfect

Color: White.

Density: 2 - 3, Average = 2.5

Diaphaniety: Translucent to Opaque

Fracture: Uneven - Flat surfaces (not cleavage) fractured in an uneven pattern.

Habit: Aggregates - Made of numerous individual crystals or clusters.

Hardness: 1-2 - Between Talc and Gypsum

Luminescence: Fluorescent.

Luster: Earthy (Dull)

Streak: white

Optical Properties of Hectorite

Gladstone-Dale: CI meas= 0.055 (Good) - where the CI = (1-K_{PDmeas}/KC)
CI calc= 0.058 (Good) - where the CI = (1-K_{PDcalc}/KC)
K_{PDcalc}= 0.2005, K_{PDmeas}= 0.2013, KC= 0.2129

Optical Data: Biaxial (-), a=1.49, b=1.5, g=1.52, bire=0.0300

Pleochroism (x): colorless.

Pleochroism (y): colorless.

Pleochroism (z): colorless.

Calculated Properties of Hectorite

Electron Density: $\rho_{electron}$**=2.50 gm/cc**
note: $\rho_{Hectorite}$ =2.50 gm/cc.

Fermion Index Fermion Index = 0.03146
Boson Index = 0.96854

Photoelectric: $PE_{Hectorite}$ **= 1.56** barns/electron
U=$PE_{Hectorite}$ x $\rho_{electron}$= 3.89 barns/cc.

Radioactivity: **GRapi = 0** (Gamma Ray American Petroleum Institute Units)

Hectorite is **Not Radioactive**

Hectorite Classification

Dana Class: **71.3.1b.4** (71)Phyllosilicate Sheets of Six-Membered Rings
(71.3)with 2:1 clays
(71.3.1b)Smectite group (Trioctahedral Smectites)

71.3.1b.1 Sobotkite? (K,Ca0.5)0.33(Mg,Al)3(Si3Al)O10(OH)2·1-5(H2O) Unk. Mono

71.3.1b.2 Saponite (Ca/2,Na)0.3(Mg,Fe)3(Si,Al)4O10(OH)2·4(H2O) C 2/m 2/m

71.3.1b.2a Ferrosaponite! Ca0.3(Fe,Mg,Fe)3(Si,Al)4O10(OH)2·4(H2O) C? Mono

71.3.1b.3 Sauconite Na0,3Zn3(Si,Al)4O10(OH)2·4(H2O) C 2/m 2/m

71.3.1b.4 Hectorite Na0,3(Mg,Li)3Si4O10(OH)2 C 2/m 2/m

71.3.1b.5 Pimelite Ni3Si4O10(OH)2·4(H2O) Unk. Hex

71.3.1b.6 Stevensite (Ca0.5,Na)0.33(Mg,Fe)3Si4O10(OH)2·n(H2O) Unk (ORTH ?) Mono

71.3.1b.7 Yakhontovite (Ca,K)0.5(Cu,Fe,Mg)2Si4O10(OH)2·3(H2O) C 2/m 2/m

71.3.1b.8 Zincsilite Zn3Si4O10(OH)2·4(H2O)(?) C 2/m ? 2/m

Strunz Class: **VIII/H.20-10** VIII - Silicates
VIII/H - Phyllosilicates (layered) Mica like with [Si4O10]4- and related groups
VIII/H.20 - Hectorite - Zincsilite series

VIII/H.20-10 Hectorite Na0,3(Mg,Li)3Si4O10(OH)2 C 2/m 2/m

VIII/H.20-20 Saponite (Ca/2,Na)0,3(Mg,Fe)3(Si,Al)4O10(OH)2·4(H2O) C 2/m 2/m

VIII/H.20-27 Ferrosaponite! Ca0.3(Fe,Mg,Fe)3(Si,Al)4O10(OH)2·4(H2O) C? Mono

VIII/H.20-30 Spadaite MgSiO2(OH)2·(H2O)(?) None

VIII/H.20-40 Stevensite (Ca0.5,Na)0.33(Mg,Fe)3Si4O10(OH)2·n(H2O) Unk (ORTH ?) Mono

VIII/H.20-50 Sauconite Na0,3Zn3(Si,Al)4O10(OH)2·4(H2O) C 2/m 2/m

VIII/H.20-60 Zincsilite Zn3Si4O10(OH)2·4(H2O)(?) C 2/m ? 2/m

Other Hectorite Information

References: NAME(MinRec) PHYS. PROP.(Enc. of Minerals,2nd ed.,1990) OPTIC PROP.(Enc. of Minerals,2nd ed.,1990)

See Also:

Links to other databases for Hectorite :
1 -Am. Min. Crystal Structure Database 2 -Athena 3 -EUROmin Project 4 -Google Images 5 -Google Scholar 6 -Handbook of Mineralogy (MinSocAm) 7 -Handbook of Mineralogy (UofA) 8 -MinDAT 9 -MinMax(Deutsch) 10 -MinMax(English) 11 -Mineralienatlas (Deutsch) 12 -QUT Mineral Atlas 13 -École des Mines de Paris

Search for Hectorite using:

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Mineral Auctions - Trinity Mineral Company
Mineral News
Mineral of the Month Club
Mineralsweb - Gobin
Minernet.it Minerals
Phoenix Orion Treasures
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Wright's Rock Shop

Translate Hectorite Mineral Data :

Ask about Hectorite here :

Ask-A-Mineralogist from the Mineralogical Society of America
Mindat.org's Discussion Groups
Original Rockhounds Discussion Group
Rockhounds Discussion Group on Yahoo Groups

Print or Cut-and-Paste your Hectorite Specimen Label here :

Hectorite

$Na_{0.3}(Mg,Li)_3Si_4O_{10}(OH)_2$
Dana No: **71.3.1b.4** Strunz No: **VIII/H.20-10**

Locality:

Notes:

Print this Label

Oilfield Gl

hectorite

1. *n.* [Drilling Fluids]

A clay mineral similar in structure to bentonite but with more negative charges on its surface hectorite, made by the wet process, is a premium performance additive for use in oil-base d

See: bentonite, clay, clay, invert-emulsion oil mud, oil mud, organophilic clay, smectite

Hectorite $Na_{0.3}(Mg, Li)_3Si_4O_{10}(OH)_2$

Crystal Data: Monoclinic. *Point Group:* $2/m$. As thin laths, to 2 μm, and as aggregates of such laths.

Physical Properties: *Cleavage:* {001}, perfect. *Fracture:* Uneven. Hardness = 1–2 D(meas.) = ~2.3 D(calc.) = n.d. Swells on addition of H_2O. Positive identification of minerals in the smectite group may need data from DTA curves, dehydration curves, and X-ray powder patterns before and after treatment by heating and with organic liquids.

Optical Properties: Translucent, transparent in thin section. *Color:* White, cream, pale brown, mottled. *Luster:* Earthy to waxy, dull.
Optical Class: Biaxial (–). α = ~1.49 β = 1.50 γ = 1.52 2V(meas.) = Small.

Cell Data: *Space Group:* $C2/m$. $a = 5.2$ $b = 9.16$ $c = 16.0$ $\beta = \sim 99°$ Z = n.d.

X-ray Powder Pattern: Hector, California, USA; spacings variable by humidity, intensities variable by orientation.
4.58 (100), 1.53 (100), 15.8 (80), 2.66 (80), 1.32 (80), 1.30 (80), 2.48 (60)

Chemistry:

	(1)	(2)
SiO_2	53.68	53.95
TiO_2		trace
Al_2O_3	0.60	0.14
Fe_2O_3		0.03
MgO	25.34	25.89
CaO	0.52	0.16
Li_2O	1.12	1.22
Na_2O	3.00	3.04
K_2O	0.07	0.23
Cl	0.31	
H_2O^+	8.24	5.61
H_2O^-	7.28	9.29
Total	100.16	99.56

(1) Hector, California, USA; corresponds to $(Na_{0.42}Ca_{0.04}K_{0.01})_{\Sigma=0.47}(Mg_{2.73}Li_{0.33})_{\Sigma=3.06}(Si_{3.89}Al_{0.05})_{\Sigma=3.94}O_{10}(OH)_2$. (2) Do.; corresponds to $(Na_{0.42}K_{0.02}Ca_{0.01})_{\Sigma=0.45}(Mg_{2.78}Li_{0.36})_{\Sigma=3.14}(Si_{3.89}Al_{0.01})_{\Sigma=3.90}O_{10}(OH)_2 \cdot 0.35H_2O$.

Mineral Group: Smectite group.

Occurrence: In a bentonite deposit, altered from clinoptilolite derived from volcanic tuff and ash with a high glass content, related to hot spring activity (Hector, California, USA).

Association: Calcite, clinoptilolite (Hector, California, USA).

Distribution: In the USA, five km south of Hector, San Bernardino Co., California; in the Lyles deposit, 38 km northeast of Hillside, Yavapai Co., Arizona; and at Disaster Peak, in the Montana Mountains, near McDermitt, Disaster district, Humboldt Co., Nevada. From around Puy Chalard, Puy-de-Dôme, France. In the Balıkesir colemanite deposit, Balıkesir Province, Turkey.

Name: For the locality at Hector, California, USA.

Type Material: n.d.

References: (1) Foshag, W.F. and A.O. Woodford (1936) Bentonitic magnesian clay-mineral from California. Amer. Mineral., 21, 238–244. (2) Strese, H. and U. Hofmann (1941) Synthesis of magnesium silicate gels with two-dimensional regular structure. Zeit. anorginsche allgemeine Chemie, 247, 65–95. (3) (1944) Amer. Mineral., 29, 73 (abs. ref. 2). (4) Nagelschmidt, G. (1938) On the atomic arrangement and variability of the members of the montmorillonite group. Mineral. Mag., 25, 140–155. (5) Deer, W.A., R.A. Howie, and J. Zussman (1963) Rock-forming minerals, v. 3, sheet silicates, 226–245.